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# SEFSC Coral Reef Program: FY 2012 Project Accomplishments Report

Compiled by:  
Jennifer Schull



U.S. DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service  
Southeast Fisheries Science Center  
75 Virginia Beach Drive  
Miami, Florida 33149

August 2013





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U.S. DEPARTMENT OF COMMERCE  
Penny Pritzker, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION  
Kathryn D. Sullivan, Acting Undersecretary for Oceans and Atmosphere

NATIONAL MARINE FISHERIES SERVICE  
Samuel D. Rauch III, Acting Assistant Administrator for Fisheries

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National Marine Fisheries Service  
Southeast Fisheries Science Center  
75 Virginia Beach Drive  
Miami, Florida 33149

or

National Technical Information Service  
5825 Port Royal Road  
Springfield, Virginia 22161  
(703) 487-4650  
FAX: (703) 321-8547  
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Cover photograph: Haitian fishermen prepare their handlines for fishing at Navassa Island, March 2012

**SEFSC Coral Reef Program: FY 2012 Project Accomplishments Report  
Table of Contents**

I. INTRODUCTION ..... 1

II. PROGRAM COORDINATION ..... 2

**Schull:** SEFSC Coral Reef Conservation Program Coordination and Communication..... 2

III. REDUCE ADVERSE IMPACTS OF FISHING ..... 5

**Kellison:** Assessing the Locations and Status of Reef Fish Spawning Aggregations in the Florida Keys .. 5

**Ruttenberg:** Assess and Monitor Coral Reef MPAs ..... 8

**Ruttenberg:** Evaluation of Response Metrics in Reef Fish Communities: What Are Our Measurements Telling Us? ..... 12

**Ruttenberg:** The Importance of Parrotfish (fam. Scaridae) on the Maintenance and Recovery of Coral-dominated Reefs ..... 14

IV. REDUCE IMPACTS OF CLIMATE CHANGE ..... 16

**Lamkin:** Developing Downscaled Climate Models for Coral Reef Management Into the 21st Century 16

**Miller:** Climate Change Impacts: Potential for Recovery/Resilience of Corals and Algal Interference .. 19

V. SOCIOECONOMICS..... 22

**Agar:** Socioeconomic Assessment of the St. Croix Gill and Trammel Net Ban ..... 22

VI. PROTECTED CORALS ..... 25

**Miller:** Evaluation of ESA listed *Acropora* spp. Status and Actions for Management and Recovery ..... 25

VII. COUNCIL COOPERATIVE AGREEMENT ACTIVITIES..... 29

**David:** South Atlantic Bight MPAs and Deepwater Coral HAPCs: Characterization of Benthic Habitat and Fauna..... 29

**David:** Synthesis of Information on Octocoral Biology, Ecology, and Fisheries in the South Atlantic in Support of Effective Management..... 29

**David:** Survey of Habitat and Fish Assemblages in Three Marine Reserves on the West Florida Shelf . 29

VIII. LIST OF ACRONYMS..... 33



## I. INTRODUCTION

The NOAA Coral Reef Conservation Program (CRCP) is a matrix program administered by NOAA's National Ocean Service (NOS) and operating across four NOAA line offices: NOS, National Marine Fisheries Service (NMFS), National Environmental Satellite, Data, and Information Service (NESDIS), and Oceanic and Atmospheric Research (OAR). The program supports coral reef regions of the United States (U.S.), has an international component, and is integrated with other federal agencies, states, territories and commonwealths, and local governments. In September 2007, CRCP conducted an external program review for an assessment of the CRCP's effectiveness in achieving its mandates and to provide recommendations for improving its impact and performance. Recommendations from this review, along with the subsequent planning process (the "roadmap") shaped the recent history of the CRCP. In 2011, CRCP welcomed a new program manager, John Christensen, to lead the program forward. 2012 ushered in the first activities under the new National Coral Reef Monitoring Plan (NCRMP).

The Southeast Fisheries Science Center (SEFSC) has had a leadership role in coral reef conservation science since 1978. Congress passed the Coral Reef Conservation Act in 2000 and SEFSC was able to dovetail its management-relevant coral reef science with the developing directives of the NOAA CRCP. SEFSC has maintained a strong coral reef science program since inception of the CRCP in 2001, and has continued to deliver high-caliber, peer-reviewed science in support of coral reef conservation and management and other NMFS mandates to conserve the nation's fisheries, essential fish habitat, and protected species. The reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act (2006) is putting a heavier burden on data quality in many coral reef ecosystems. Additionally, the listing of two Atlantic corals as threatened under the Endangered Species Act (ESA) in 2006, and the petition to list an additional 83 species of coral in 2009, underscores the importance of NMFS as a critical regulatory authority to effect change in coral reefs.

In Fiscal Year (FY) 2012, CRCP supported 12 SEFSC-led projects totaling \$1.64M, plus resources to send two scientists to attend the International Coral Reef Symposium in Australia. While most projects addressed fishing impacts or the status and recovery of protected coral species, SEFSC also tackled projects looking at climate impacts on reef ecosystems by downscaling global climate models to a regional scale, and exploring the impacts of climate on coral spawning and settlement. Two new projects were funded: one looking at the socioeconomic impacts of the gill and trammel net buy-back in the U.S. Virgin Islands (USVI), and another exploring the use of different response metrics for fish monitoring programs. SEFSC continued its leadership role with the status review for 82 corals petitioned for listing under the ESA, and helped host listening sessions so the public could provide additional input into the listing decision. Dr. Margaret Miller served on the Biological Review Team for the April 2012 status review and draft management report on the 82 corals. SEFSC explored the impact of parrotfish and other herbivores on the persistence and recovery of protected corals. Work continued on reef fish distribution and abundance in support of ecosystem, fisheries, and place-based management. Work also continued on behavioral ecology of reef fish spawning aggregations in an effort to identify and protect these important assets. Significant attention was given to the development of NCRMP, and a pilot NCRMP mission was conducted in St. Croix. By relying on peer-reviewed best practices and ongoing partnerships, CRCP is on the path to developing a state of the art, cost effective and scientifically rigorous monitoring program across coral reef jurisdictions in the U.S. SEFSC is proud to be an integral part of the development of NCRMP.

As part of NMFS, SEFSC plays a critical role in the Southeast, Caribbean and Gulf regions in providing the science to support the agency's regulatory responsibilities. For the second year in a three year cycle, SEFSC worked collaboratively with the regional Fishery Management Councils on research programs that meet the Councils' needs. By working together, SEFSC is helping address marine protected area (MPA) and other fisheries management questions in both the South Atlantic and Gulf of Mexico.

This annual accomplishments report provides information on the activities and accomplishments of SEFSC's projects funded by the CRCP in FY12, organized by the program's newly refined and narrower goals and objectives. SEFSC gratefully acknowledges funding from NOAA's CRCP.

## II. PROGRAM COORDINATION

<b>Project ID#:</b>	1250-2012
<b>Title:</b>	SEFSC Coral Reef Conservation Program Coordination and Communication
<b>PIs and co-PIs:</b>	Jennifer Schull (SEFSC)
<b>Duration of Project:</b>	Year 2 of 3
<b>Project Category:</b>	Program Coordination

### **Brief description of activities conducted in FY2012**

This project provided coordination and communications assistance for SEFSC's portfolio of coral reef related activities for FY12. It covered SEFSC participation in working groups, coordination of SEFSC projects, budgets, accomplishments reporting, and proposal development. It ensured SEFSC participation in all CRCP-related strategic planning initiatives, and ensured all SEFSC activities were integrated with and communicated to the relevant management entities. This project ensured SEFSC representation in the NCRMP development and planning processes.

### **Description of accomplishments & results**

In FY12, the Program Coordinator served as the principal SEFSC point of contact for the CRCP's status and trends monitoring program, co-leading the Atlantic Biological Monitoring initiative. The Program Coordinator helped formulate a pilot NCRMP monitoring activity in St. Croix, USVI, develop FY13-15 work plans for the Atlantic Biological group, generate the benthic protocols, and participated in several meetings to refine the structure and implementation of NCRMP as a whole. Because NCRMP will now work collaboratively with partners, this project ensured frequent communication with established and new partners, so they were aware of and contributing to the evolution of NCRMP.

The Program Coordinator coordinated all SEFSC projects in FY12 including coordination of the FY12 pre-proposal and proposal portfolios, and then executed all reporting, contracting, and budget requirements for the approved projects. The Program Coordinator submitted updates to CRCP regarding project progress, accomplishments, missions and publications, and monitored SEFSC Principal Investigator (PI) input into CoRIS (Coral Reef Information System). The Program Coordinator maintained and increased relationships with key management partners (i.e. Fishery Management Councils and State of Florida), including integration of fish monitoring activities in the Southeast Florida Coral Reef Initiative region (SEFCRI) with the ongoing Reef Visual Census (RVC) in the Florida (FL) Keys to advance NCRMP. The Program Coordinator helped coordinate interviews with PIs for the Smithsonian's Ocean Hall in Washington, DC, and facilitated four CRCP seminars given by SEFSC scientists: Margaret Miller, Ron Hill, Ben Ruttenberg, and Barbara Muhling. During FY12, SEFSC's coral reef program accomplishments were published in the FY10 SEFSC Accomplishments Report (March 2012) and all FY11 accomplishments were entered into the CRCP database. FY13 proposals were scoped and coordinated and SEFSC successfully hosted CRCP Fisheries staff, Tauna Rankin, for the annual coordination meeting. The Program Coordinator also hired and supervised a part-time graduate student intern who wrote a synoptic 2007-2010 accomplishments report for SEFSC's coral reef related programs.

The Program Coordinator continued to represent SEFSC on CRCP issues concerning fishing impacts implementation planning, performance measures, database redesign, data management, outreach and

communications, international activities, etc., ensured planning documents were reviewed by subject matter experts, and coordinated grant reviews for several CRCP grant programs. The Program Coordinator participated in the October 2011 U.S. Coral Reef Task Force Meeting (CRTFM) in Ft. Lauderdale, FL, and the Octocoral Identification Workshop at Nova Southeastern University (NSU), and prepared input for CRCP's annual report to Congress. The Program Coordinator facilitated activities with the Southeast Regional Office (SERO) in support of the parrotfish Biological Opinion, the potential listing decision on 82 coral species, and the use of fishery independent data to support stock assessment in the U.S. Caribbean. The Program Coordinator was part of the team that organized the 82 coral decision "regional listening sessions" designed for public input to the listing decision and participated in the development of the NOAA Caribbean Strategy, the NMFS Science and Technology International Implementation Plan, and provided input for the NOAA National Climate Impacts review document. The Program Coordinator coordinated scientific content development for the Smithsonian Oceans Hall and the Miami Science Museum and participated in coral reef dive activities including RVC and NCRMP programs, and the March 2012 Living Oceans Foundation-funded research mission to Navassa Island (under the leadership of PI Margaret Miller).

#### **How project supports goals & objectives of CRCP**

This project ensures that the SEFSC is fully engaged in CRCP-related programs and generates projects and outputs aligned with the goals and objectives of the CRCP and meet the needs of the coral reef management community. It ensures that SEFSC PI's are responsive to CRCP needs and that SEFSC speaks with one voice. Additionally, this project ensures that SEFSC's coral-related activities are communicated to a wide variety of audiences.

#### **How project supports management of coral reef resources**

This project guides development of coral-related projects that will have meaningful impacts on the conservation and management of coral reefs. It synthesizes the expert advice and scientific outputs of SEFSC coral reef related projects for incorporation into scientifically sound management actions. It integrates CRCP-related outputs with those from other NMFS activities related to habitat, sustainable fisheries, and protected species. It also integrates SEFSC's coral reef activities with other NOAA and NMFS engagement nationally and internationally such as NOAA in the Caribbean and the NOAA Caribbean Strategy.

#### **List of project partners and their roles**

None

#### **Communications, media exposure, capacity building, education and outreach activities**

- Supervised a part-time intern who published a synoptic coral reef accomplishments report as her final product in October 2012 (see below). The goal was to hone science writing and communications skills during her internship at SEFSC. At the end of the internship, she was awarded a Knauss Fellowship in Silver Spring.
- Gave an intimate presentation to Dr. Lubchenco on the CRCP funded Trap Study in St. Croix, and met with Andy Weiner, NOAA's head of External Engagement, during the CRTFM.
- Worked with both the Smithsonian Oceans Hall and the Miami Science Museum to develop video and scientific content for exhibits and special events, and facilitated SEFSC scientist's presentations to CRCP.
- Completed the 2010 SEFSC Accomplishments Report as a NOAA Tech Memo (see below).
- Maintained active dive status to assist PIs with field work needs.

- Represented SEFSC on a variety of CRCP and NOAA working groups and reported on scientific accomplishments, discoveries, publications and media to a variety of sources.

**Submissions to CoRIS**

SEFSC Coral Reef Program: FY2010 Project Accomplishment Report. Compiled by Jennifer Schull. NOAA Technical Memorandum. NMFS-SEFSC-628, 44p.

**FY2012 Publications**

SEFSC Coral Reef Program: FY2010 Project Accomplishment Report. Compiled by Jennifer Schull. NOAA Technical Memorandum. NMFS-SEFSC-628, 44p.

**FY2012 Presentations**

None

**Setbacks or challenges encountered in FY2012**

None

**Comments on future direction of project**

This project is ongoing and provides valuable oversight and coordination of SEFSC's coral-related activities.

### III. REDUCE ADVERSE IMPACTS OF FISHING

<b>Project ID#:</b>	1317-2012
<b>Title:</b>	F082 Assessing the Locations and Status of Reef Fish Spawning Aggregations in the Florida Keys
<b>PIs and co-PIs:</b>	Todd Kellison (SEFSC) and Chris Taylor (NOS)
<b>Duration of Project:</b>	Year 1 of 1; ongoing project
<b>Project Category:</b>	Reduce Adverse Impacts of Fishing

#### **Brief description of activities conducted in FY2012**

The PIs continued efforts to identify and assess reported reef fish spawning aggregations (FSAs) in the FL Keys. Building on their prior research in the upper and lower FL Keys, the team focused on multiple sites in the lower and middle Keys to accomplish two objectives: (1) assess whether reported FSA sites are characterized by similar habitat characteristics, with a focus on geomorphological features, and (2) assess fish utilization patterns of reported FSA sites.

#### **Description of accomplishments & results in FY2012:**

The team used a combination of aerial surveys, acoustic surveys, and diver based surveys for this project. The team performed acoustic surveys and created a bathymetric map of a reported reef fish aggregation area off Big Pine Key (middle FL Keys). They performed exploratory acoustic and diver surveys at reported aggregation sites off Big Pine Key in May and June and continued monitoring a mutton snapper aggregation site off Key West during May and June spawning moons. A second mutton snapper aggregation site off Key West was also identified and monitored. The team continued monitoring two reported gray snapper aggregation sites off Key West during June (full moon), July (new moon) and August (full moon and new moon), and identified two new reported gray snapper aggregation sites off Key West. These new sites were mapped and monitored for fish utilization patterns during July (new moon) and August (full moon and new moon).

The team received reports from multiple sources that considerable numbers of muttons were being landed near Key West from sites called Eyeglass Bar and Western Dry Rocks on the May and June moons. Project participants observed elevated fishing pressure for mutton snapper near Eyeglass Bar, both from on-water and aerial surveys, but observed minimal fishing activity at Western Dry Rocks and did not acoustically mark many fish there. The project participants did make multiple observations of aggregated gray snappers during multiple spawning moons at Western Dry Rocks, and at a newly identified site called Mangrove Topino. Aggregations ranged in size from tight schools of ~ 50 fish to more than 1,000 fish. Probable spawning coloration was observed in a large aggregation at the Mangrove Topino site, when 5-10% of fish displayed a “bar-back” pattern previously unobserved on gray snapper by project participants.

The project team communicated results regularly with partners at the Florida Keys National Marine Sanctuary (FKNMS), and the public, including (a) sending regular updates to FKNMS managers, (b) giving a presentation to the FKNMS Advisory Council and (c) providing interviews on a FL Keys radio-broadcast fishing show. Additionally, they provided detailed results regarding mutton snapper spawning aggregations to guide decision-making by a South Atlantic Fishery Management Council (SAFMC)-affiliated Interdisciplinary Planning Team (IPT) considering alternatives for mutton snapper management

(SAFMC Options Paper - Regulatory Amendment 14 to the Fishery Management Plan (FMP) of the Snapper Grouper Fishery of the South Atlantic Region).

**How project supports goals & objectives of CRCP**

This project addresses CRCP Objective F2.4, “work with relevant agencies, offices, and communities to create, implement, and improve the management of MPAs that protect key coral reef ecosystem components and functions.” Team results will help managers in the FL Keys meet their Jurisdictional Objective A1.2 in developing a comprehensive zoning plan in terms of evaluation of the location, size and rezoning of Sanctuary Preservation Areas (i.e., no-take areas).

**How project supports management of coral reef resources**

The protection and conservation of FSAs is critical to the sustainable management of grouper, snapper and other reef fish fisheries, from both fisheries and ecosystem perspectives. Results from this ongoing research effort will help to identify aggregation locations and thus facilitate sustainable management for the aggregating species. FKNMS managers – who are embarking on an evaluation of their zoning strategy - are kept abreast of research results (via direct communication from project PIs) and directly support the research through making resources available for use (e.g., vessels and docking facilities).

This project also provided detailed results regarding mutton snapper spawning off Key West to guide decision-making by a SAFMC-affiliated Interdisciplinary Planning Team considering alternatives for mutton snapper management (SAFMC Options Paper - Regulatory Amendment 14 to the FMP of the Snapper Grouper Fishery of the South Atlantic Region).

**List of project partners and their roles**

- NOAA NOS (NCCOS/CCFHR), Chris Taylor: co-PI on the project
- University of Miami, Dr. Art Gleason: mapping component
- State of Florida Fish and Wildlife Conservation Commission (FWC), multiple personnel: cooperative field sampling and data analysis

**Communications, media exposure, capacity building, education and outreach activities**

PIs Kellison and Taylor participated in a radio interview focusing on FL Keys spawning aggregation research on Keys Radio 107.1FM in April 2013. PIs also sent regular updates to FKNMS managers and made a presentation to the FKNMS Advisory Council.

**Submissions to CoRIS**

None

**FY2012 Publications**

None

**FY2012 Presentations**

Morley, D, **GT Kellison**, C Taylor, A Gleason, M Feeley and A Acosta. 2011. Reef fish spawning aggregations in the FL Keys 64<sup>th</sup> Gulf and Caribbean Fisheries Institute Symposium, Puerto Morales, Mexico

Morley, D, **GT Kellison**, A Acosta, C Taylor, A Gleason, M Feeley, and J Hunt. 2011. Reef fish spawning aggregations in the FL Keys. FKNMS Advisory Panel

Binder, B, A Acosta, D Morley, **GT Kellison**, C Taylor and A Gleason. 2012. Estimating Fishing Intensity on Spawning Aggregation Sites by Means of Aerial Survey in the FL Keys. Florida Chapter of the AFS.

**Setbacks or challenges encountered in FY2012**

None

**Comments on future direction of project**

A new multibeam system purchased towards the end of this year's project cycle showed great promise and utility and will be fully utilized next year.



Gray snapper aggregation in the FL Keys (photo credit: Todd Kellison).

<b>Project ID#:</b>	1064 - 2012
<b>Title:</b>	F180 Assess and Monitor Coral Reef MPAs
<b>PIs and co-PIs:</b>	PI: Benjamin Ruttenberg (SEFSC); co-PIs: Jim Bohnsack (SEFSC), Jerry Ault (UM-RSMAS), Steven Smith (UM-RSMAS)
<b>Duration of Project:</b>	Year 1 of 1, ongoing project
<b>Project Category:</b>	Reduce Adverse Impacts of Fishing

**Brief description of activities conducted in FY2012**

The FY12 goals of the project were to continue long-term monitoring efforts of coral reef fish and habitat in the FL Keys and the Dry Tortugas region using the RVC method pioneered by Bohnsack and Bannerot (1986). Results are used to (1) assess the effects of marine reserves and other management zones in the FL Keys and Tortugas regions, and (2) improve understanding of ecosystem dynamics and guide ecosystem management, including the maintenance of sustainable fisheries. Sampling uses non-destructive visual assessments based on a stationary-diver technique deployed in a two-stage, stratified random sampling design.

Sampling in the FL Keys has occurred since 1979. Beginning in FY08, the State of Florida’s Fish and Wildlife Research Institute (FWRI) and the National Park Service (NPS) agreed to perform cooperative sampling and subsequent data sharing with SEFSC, and this collaboration began in earnest in FY09. Sampling in the Dry Tortugas region occurred irregularly from 1994-1999, and has occurred every two years since 2000. However, a no-take marine reserve was implemented in Dry Tortugas National Park in early 2007, with an agreement to evaluate its effectiveness in 5 years. FY12 sampling began in June, and included 416 sites and 1,594 research dives in the FL Keys (including Biscayne National Park), and 424 sites and 1,599 research dives in the Dry Tortugas Region. Staff from SEFSC, NPS, FWRI, University of Miami- Rosenstiel School of Marine and Atmospheric Science (UM-RSMAS), NSU and Florida International University (FIU) participated in field research efforts. SEFSC staff also partnered with researchers supporting fish monitoring in the northern portion of the Florida reef tract (SEFCRI). A new mapping application developed by SEFSC helped program partners track effort and site completion.

All data have been entered and passed through the quality assurance/quality control (QA/QC) procedures. The team will use FY12 data to generate sampling points for FY14 NCRMP surveys. Additionally, project personnel discovered RVC datasheets from the 1980s and added them to the database.

**Description of accomplishments & results**

In FY12, divers conducted photo-documentation, RVC fish surveys, and habitat assessments at 416 sites in the FL Keys and 424 sites in the Dry Tortugas (4 divers/site). SEFSC divers collaborated with the UM-RSMAS, FKNMS, FWRI, and the NPS (South Florida and Caribbean Network), as well as new partners in the SEFCRI region. In total, 3193 dives were needed to complete the 2012 mission to monitor reef fish community composition, habitat composition, and abundance and size structure for more than 300 reef fish species on Florida's coral reef tract. Data are used to assess population and habitat trends (e.g., whether species are overfished) and ecosystem responses to fisheries management actions, including determining the effectiveness of no-take MPAs.

SEFSC personnel discovered old analog datasheets that had not been entered or integrated into the newer enterprise level database. Project personnel entered 154 records, assigning primary units, stations and associated information, and conducting all QA/QC. With this completed, all historical database records from 1979-1993 (over 3100 records) are completely up to date and in-line with current data collection and analysis protocols.

#### **How project supports goals & objectives of CRCP**

Monitoring of coral reef fish and habitat resources is critical to the assessment of ecosystem status and the effectiveness of management actions, particularly as they relate to MPAs and the effects of fishing on coral reef ecosystems.

#### **How project supports management of coral reef resources**

All data and analytical results are shared with FWRI, NPS, and FKNMS managers to support and guide management decisions within Florida's coral reef ecosystems.

#### **List of project partners and their roles**

- UM-RSMAS: created survey design; assist with data collection and with data analyses and writing of technical reports  
FWRI: assisted with data collection
- NPS: assisted with data collection

#### **Communications, media exposure, capacity building, education and outreach activities**

This partnership with the State of Florida and NPS has resulted in significant improvements in sampling power and project benefits to NOAA, the State of Florida, NPS, and FKNMS managers. SEFSC also worked closely with and co-trained the partners for the monitoring program being developed in the SEFCRI region.

#### **Submissions to CoRIS**

FY12 Metadata has been submitted to CoRIS.

#### **FY2012 Publications**

Ault, J.S., S.G. Smith, J.A. Bohnsack, J. Luo, N. Zurcher, D.B. McClellan, T.A. Ziegler, D. E. Hallac, M. Patterson, M.W. Feeley, B.I. Ruttenberg, J Hunt, D. Kimball, B. Causey. 2013. Assessing coral reef fish population and community changes in response to marine reserves in the Dry Tortugas, Florida, USA. *Fish. Research* 144:28-37.

Ault, J.S., J. Luo, S.G. Smith, and D.B. McClellan. 2012. CH 11: Larval transport modeling to assess the reproductive potential of reef-fishes spawning in the Dry Tortugas region. Pages 56-61 in *Implementing the Dry Tortugas National Research Natural Area Science Plan: The 5-Year Final Report 2012*. South Florida Natural Resources Center, Everglades and Dry Tortugas National Parks, Homestead, FL and the Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Ault, J.S., S.G. Smith, T. Switzer, J.A. Bohnsack, M. Patterson, M.W. Feeley, D.B. McClellan, B.I. Ruttenberg, D. Hallac, T. Ziegler, J. Hunt, and D. Kimball. 2012. CH 1: Status of reef fish resources of the Tortugas region based on fishery-independent visual and trap survey assessments. Pages 4-13 in *Implementing the Dry Tortugas National Research Natural Area Science Plan: The 5-Year Final Report 2012*. South Florida Natural Resources Center, Everglades

and Dry Tortugas National Parks, Homestead, FL and the Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Ault, J.S. and J.A. Bohnsack. 2012. No-take marine reserves are an important management strategy for exploited reef fish stocks. In '*Tropical Connections: South Florida's Marine Environments*'. W. Kruczynski and P.J. Fletcher (eds.). IAN Press, Cambridge, MD. 492 pp.

Ault, J.S. 2012. Marine and estuarine habitats in south Florida are physically and biologically connected. In '*Tropical Connections: South Florida's marine environment*'. W. Kruczynski and P. Fletcher (eds.). IAN Press, Cambridge, MD. 492 pp.

Ault, J.S. 2012. Overfishing has reduced fish stocks in south Florida. In '*Tropical Connections: South Florida's marine environment*'. W. Kruczynski and P. Fletcher (eds.). IAN Press, College Park, MD. 492 pp.

Bohnsack, J.A. 2012. Biodiversity of reef fishes is important to the ecosystem and economy of the Florida Keys. In '*Tropical Connections: South Florida's Marine Environments*' W.L. Kruczynski and P.J. Fletcher (eds.). IAN Press, Cambridge, MD. 492 pp.

Brandt, M. E., B. I. Ruttenberg, W. J. Miller, R. Waara, B. Witcher, A. J. Estep, and M. E. Patterson. 2012. Dynamics of an acute coral disease outbreak associated with the macroalgae *Dictyota* spp. in Dry Tortugas National Park, Florida, USA. *Bull. Mar. Sci.* 88(4):1035-1050.

Feeley, M.W., D. Morley, A. Acosta, T.S. Switzer, N.A. Farmer & Ault, J.S. 2012. Spillover of select reef fish species in and near the Dry Tortugas National Park Research Natural Area. RNA Performance Topic 2. Chapter 4, Pages 24-27 in Ziegler, T.A. and Hunt, J. (eds), '*Implementing the Dry Tortugas National Park Research Natural Area Science Plan: The 5-Year Report*'. South Florida Natural Resources Center, Everglades and Dry Tortugas National Parks, Homestead, FL, and the Florida Fish and Wildlife Conservation Commission, Tallahassee, FL. 63 pp.

Ruttenberg B.I., P. J. Schofield, J.L. Akins, A. Acosta, M.W. Feeley, J. Blondeau, S.G. Smith, and J.S. Ault. 2012. Rapid invasion of Indo-Pacific lionfish (*Pterois volitans* and *P. miles*) in the Florida Keys, USA: Evidence from multiple pre- and post-invasion data sets. *Bull. Mar. Sci.* 88(4): 1051-1059.

#### **FY2012 Presentations**

Ruttenberg, B. I., J. A. Bohnsack, J. S. Ault, S. G. Smith, D. B. McClellan, D. E. Harper, J. Serafy, and K. Huebert. (2012) "Thirty years of change in reef fish communities in the Florida Keys: implications for management." *International Coral Reef Symposium*, July 2012, Cairns, Australia.

Ault, J.S. Institute for Operations Research and Management Science. (2012) Optimization Society Conference, '*Optimization and Analytics: New Frontiers in Theory and Practice*', Plenary speaker. Miami, FL.

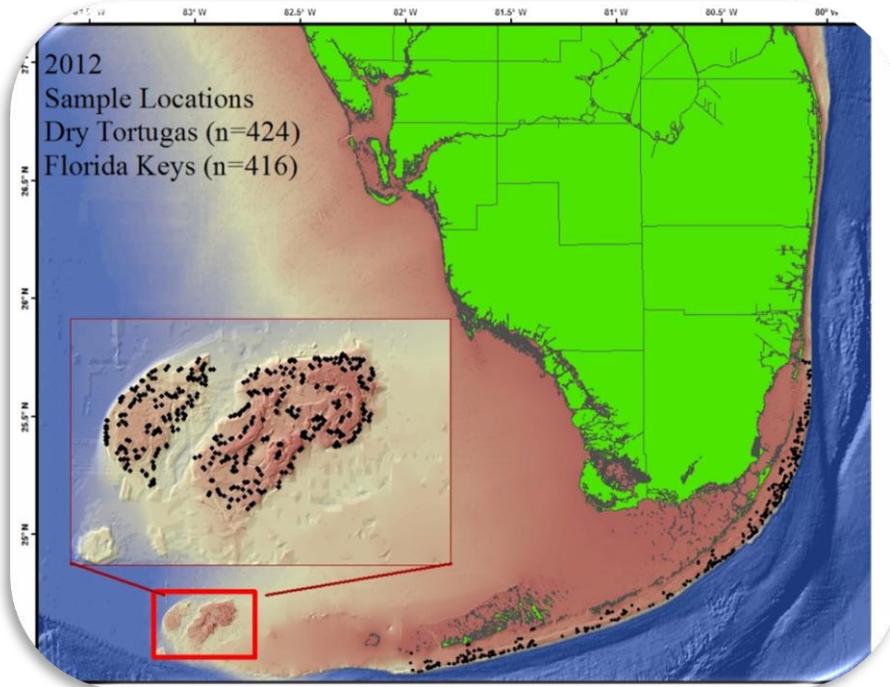
Ault, J.S. NOS Science Seminar Series. *Sustaining coral reef fisheries of Puerto Rico*. (2012). NOAA Headquarters, Silver Spring, Maryland.

**Setbacks or challenges encountered in FY2012**

None

**Comments on future direction of project**

The traditional RVC program will become part of NCRMP in FY13. NCRMP will continue RVC fish monitoring in FL and institute benthic monitoring protocols as well. NCRMP monitoring will take place on a biennial basis in each of the Atlantic jurisdictions. There will be limited activity in FL in FY13. FY14 will bring a full monitoring complement to FL and will dovetail with current SEFCRI baseline fish monitoring.



Black dots in this figure show survey locations along the FL Keys reef tract during FY12, including the Dry Tortugas region. Sites include all those surveyed by NOAA, the State of Florida, and the NPS. Four data collection dives occurred at each site.

<b>Project ID#:</b>	477 - 2012
<b>Title:</b>	Evaluation of Response Metrics in Reef Fish Communities: What Are Our Measurements Telling Us?
<b>PIs and co-PIs:</b>	PI: Benjamin Ruttenberg (SEFSC), Co-PIs: Ivor Williams (PIFSC) and Matt Kendall (NOS/BioGeo)
<b>Duration of Project:</b>	Year 1 of 1
<b>Project Category:</b>	Reduce Adverse Impacts of Fishing

#### **Brief description of activities conducted in FY2012**

A significant portion of this project was spent preparing the various CRCP fish community datasets for analysis in a common framework. In late FY12, the PIs convened a workshop of all project participants to discuss the major challenges in developing meaningful response metrics for reef fish communities. This workshop resulted in a detailed outline for the final project report, as well as matrices of various metrics and their attributes. These matrices formed the basis for Tables 1 and 2, the centerpieces of the final report, which was completed in early 2013.

#### **Description of accomplishments & results**

The final project report addressed many of the key issues involved in evaluating response metrics in reef fish communities, and how these metrics serve the different needs of the management and science communities.

#### **How project supports goals & objectives of CRCP**

CRCP has been attempting to define response metrics for the reef fish community portion of NCRMP. To date, there has been no critical evaluation of the utility of any of the possible candidate metrics that have been or may be used to describe the status of these complex reef fish communities. To address this need, the PIs initiated a project to evaluate the utility of biomass-based metrics and their relationship to other population and community response variables and determine the relative strengths and weaknesses of different metrics for different questions and situations. This report outlined the results of a workshop that included NOAA and academic scientists. The goals were (1) to clearly frame the difficulties of creating appropriate response metrics for complex monitoring programs, (2) identify a range of potential metrics, (3) develop a conceptual analytical framework to evaluate candidate metrics, and (4) outline a workplan for a future project designed to address this research question. In addition, the PIs allocated resources before and after the workshop to assemble datasets from three major NOAA coral reef fish monitoring programs. They also included the major management uses for monitoring programs, the specific information they require, as well as a list of the important attributes for all potential metrics, their links to management, and the key challenges to using each metric. The report outlines the required next steps to determine which metric, or likely collection of metrics, will be most useful in describing the status and changes of reef fish communities worldwide.

#### **How project supports management of coral reef resources**

The goal of this project was to develop a plan to evaluate response metrics in reef fish communities, a critical need for managers worldwide. The strategies the PIs outline in this document can be used to conduct a thorough evaluation of different metrics. If the project they proposed in this report is ultimately funded, they anticipate that the results of that subsequent project will help inform

monitoring programs and make the information they collect more meaningful and useful to managers worldwide.

#### List of project partners and their roles

- Scripps Institution of Oceanography University of California, San Diego- Stuart Sandin, Brice Semmens & Brian Zgliczynski: associated investigators/contributors

#### Communications, media exposure, capacity building, education and outreach activities

None

#### Submissions to CoRIS

Final Project Report “Measuring change in fish communities: from monitoring to metrics to management. Report of a workshop and recommendations for research.”

[http://docs.lib.noaa.gov/noaa\\_documents/CoRIS/Biomass\\_project\\_report\\_final.pdf](http://docs.lib.noaa.gov/noaa_documents/CoRIS/Biomass_project_report_final.pdf)

#### FY2012 Publications

None in FY12; final report submitted FY13 (see above)

#### FY2012 Presentations

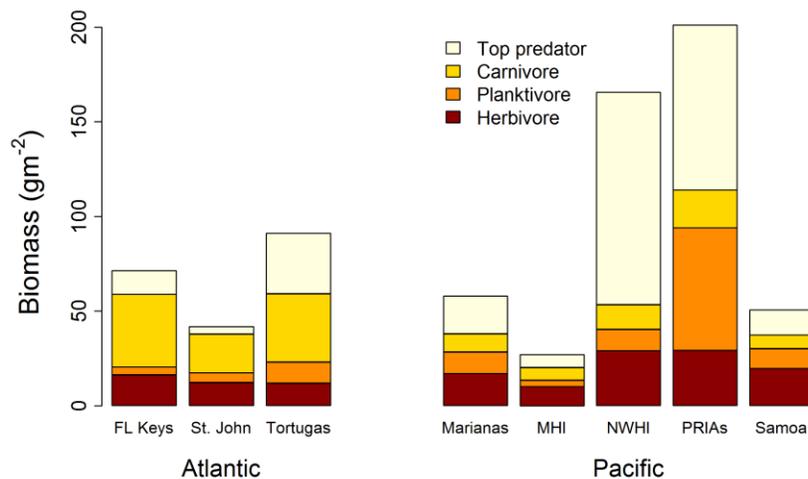
None

#### Setbacks or challenges encountered in FY2012

None

#### Comments on future direction of project

This report details the preferred approach to evaluate response metrics in reef fish communities on global and regional scales. The PIs anticipate that executing the project will require funding for a 2-year postdoctoral associate; they plan to apply for this funding in the future.



Total fish biomass across all NOAA monitored areas by trophic group

<b>Project ID#:</b>	20645-2012
<b>Title:</b>	F182 The Importance of Parrotfish (fam. Scaridae) on the Maintenance and Recovery of Coral-dominated Reefs
<b>PIs and co-PIs:</b>	Benjamin Ruttenberg (SEFSC), Margaret Miller (SEFSC), Tom Adam (Cooperative Institute of Marine and Atmospheric Studies (CIMAS)/FIU)
<b>Duration of Project:</b>	Year 2 of 2
<b>Project Category:</b>	Reduce Adverse Impacts of Fishing

#### **Brief description of activities conducted in FY2012**

The post-doctoral associate hired for this project, Thomas Adam, began his tenure in June 2012, and thus the main body of research was initiated during the last four months of FY12. In May 2012, the PIs convened a workshop to discuss the current state of knowledge regarding herbivore, algae, and coral interactions. During the workshop they identified numerous knowledge gaps, and created a detailed outline for a synthetic paper. Following the workshop, the team began a thorough review and synthesis of the existing literature based on the outline. While this synthesis was the major research focus during FY12, the PIs also initiated some field work to begin addressing critical knowledge gaps they identified. Field work conducted during FY12 aimed to quantify foraging behavior (feeding preferences, grazing rates, and foraging ranges) of several species of parrotfish to gain a better understanding of their impact on the benthic community.

#### **Description of accomplishments & results**

The outline produced in the workshop was an excellent starting point for a synthetic paper and strongly informed the direction of the field work.

#### **How project supports goals & objectives of CRCP**

CRCP aims to minimize the negative impacts of fishing on coral reef ecosystems by focusing management effort on species or functional groups which are essential for ecosystem function. While a large body of literature identifies parrotfish (and herbivores in general) as one such functional group, better information is needed about how effectively different species graze algae, and what these effects are on coral settlement, survivorship, growth, and subsequent community ecology under a range of environmental conditions. To address these needs, this project synthesizes the best scientific information available on the relationships between herbivores, coral, and algae, and begins addressing some of the key knowledge gaps.

#### **How project supports management of coral reef resources**

Herbivorous fishes (and especially parrotfishes) are a large component of many coral reef fish fisheries including those in the U.S. Caribbean, as well as important components of coral reef ecosystems. The synthesis and fieldwork currently under way will help identify which combinations of species are likely to be most effective at controlling algae and facilitating coral, ultimately informing fisheries, ecosystem, and protected species management.

#### **List of project partners and their roles**

- FIU, Deron Burkepile: academic leader
- FIU, Thomas Adam: post-doctoral associate
- Santa Barbara City College, Michelle Paddack: associated investigator/contributor

**Communications, media exposure, capacity building, education and outreach activities**

None

**Submissions to CoRIS**

None

**FY2012 Publications**

None

**FY2012 Presentations**

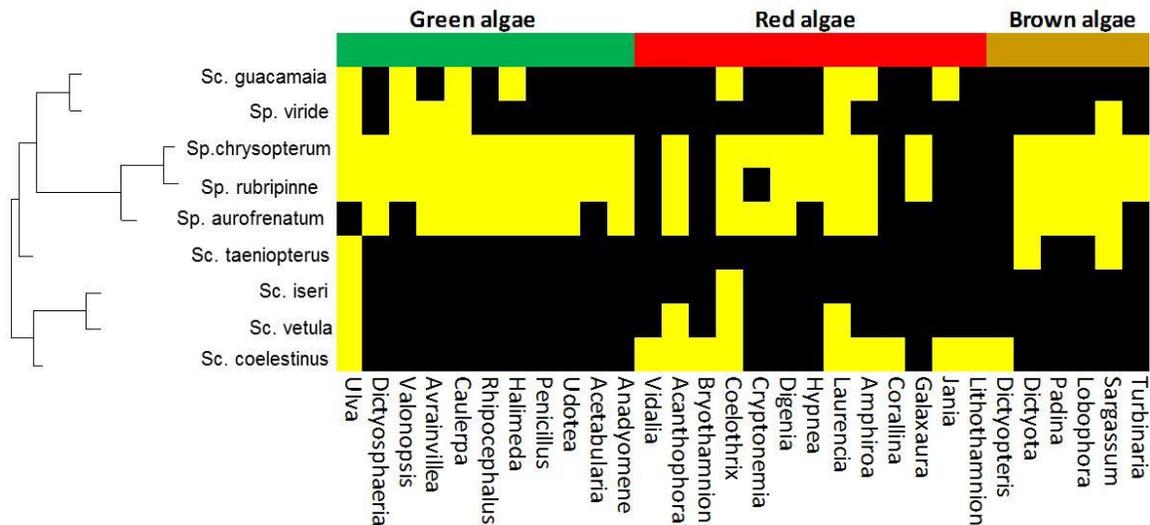
None

**Setbacks or challenges encountered in FY2012**

None

**Comments on future direction of project**

The PIs are well under way in the preparation of a manuscript that identifies and describes the major knowledge gaps identified in the May 2012 workshop. They anticipate submitting a draft of this manuscript for publication during Fall 2013. They began field work to identify feeding preferences, grazing rates, and foraging ranges of nine species of reef-associated parrotfish. These data will be used to determine the level of functional similarity that exists among different species, and to estimate the total impact of each species on corals and algae.



Diet overlap among nine species of reef-associated parrotfish. Parrotfish are clustered based on diet similarity, and yellow shading shows seaweed genera eaten by each species. Diets were determined through gut content analysis (Randall 1967) and feeding observations (Burkepille unpublished data). *Sparisoma chrysopterum*, *Sparisoma rubripinne*, and *Sparisoma aurofrenatum* feed on many species of green, red, and brown macroalgae. Their ability to remove large amounts of mature macroalgae makes them functionally important herbivores. *Sparisoma viride* and parrotfish belonging to the genus *Scarus* have more restricted diets. By scraping and excavating dead coral substrate while targeting algal turfs and endolithic algae, these parrotfish create suitable habitat for coral settlement.

#### IV. REDUCE IMPACTS OF CLIMATE CHANGE

<b>Project ID#:</b>	20692-2012
<b>Title:</b>	C169 Developing Downscaled Climate Models for Coral Reef Management Into the 21st Century
<b>PIs and co-PIs:</b>	John Lamkin (SEFSC) and Barbara Muhling (CIMAS/UM)
<b>Duration of Project:</b>	Year 2 of 3
<b>Project Category:</b>	Reduce Impacts of Climate Change

##### **Brief description of activities conducted in FY2012**

This project was initiated to create the first regional, downscaled climate model for the Gulf of Mexico and Caribbean Sea. This objective has been completed during the first two years of the project, using input from the Coupled Model Intercomparison Project Phase 3 (CMIP-3) global climate models. Downscaling was completed using the Modular Ocean Model version 4 (MOM4). In addition, a new experiment using historical data was completed, which modeled ocean conditions in the region of interest from 1871 through to the present. These new results thus complete a modeled time series of more than 200 years, encompassing both past, present and future conditions. Work has now commenced on updating the downscaled model to use the new Representative Concentration Pathway (RCP) scenarios from the CMIP-5 experiment.

##### **Description of accomplishments & results**

During FY12, global climate models from the CMIP-3 experiment were downscaled to a regional level, using the high resolution MOM4 ocean model. CMIP-3 models use CO<sub>2</sub> emission scenarios (e.g. A1B, A1FI) to quantify potential future emission scenarios, and thus environmental impacts. Work is now underway to update models to consider new CO<sub>2</sub> concentration scenarios, known as RCPs. Updating predictive models to run on these new RCPs is essential for management products and outputs to remain up-to-date and relevant.

Results to date highlight a slowing of the Atlantic Meridional Overturning Circulation (AMOC), which was evident in a predicted slowing of the Loop Current system. This will affect spatial patterns of heating and transport in the Gulf of Mexico and Caribbean Sea, with flow-on effects for coral reef ecosystems, and the organisms which rely on them. Projections of thermal stress on coral reef ecosystems were highly heterogeneous in space, as a result of these predicted oceanographic changes.

One aspect of future predictions which is not often considered is the role of natural variability. Examination of the surface temperature time series in the Gulf of Mexico during the 20<sup>th</sup> century showed a multi-decadal signal of ~0.5°C. As a result, the climate change induced warming predicted could be doubled, or nearly canceled out, due to natural variability until the mid-21st century. To investigate this further, the PIs used both observations and an ocean reanalysis simulation to recreate ocean conditions in the study region from 1871 until the present. Results highlighted the role of gyre variability and wind stress in decadal-scale oceanographic patterns, and also showed the strong divergence of predicted future conditions from any observed in the past ~130 years.

In summary, this project has resulted in a downscaled climate model for the Gulf of Mexico and Caribbean region, which can be used for any number of research and management applications.

Modeled temperature, salinity and current velocity through the water column are available at high resolution for the years 1871 – 2100, which is a first for the region. These outputs have already been requested by a number of management agencies for use in spatial planning and management.

#### **How project supports goals & objectives of CRCP**

This project directly addresses the CRCP goals of increasing coral reef resilience to climate change through effective management strategies, and identifying and understanding the vulnerability of coral reef ecosystems to climate change. In particular, results from this project will apply to objectives C3.2 (“Through process studies and modeling, develop integrated impact models of changes in coral reef ecosystems in response to the physical and chemical processes associated with climate change and ocean acidification (OA), and the interactions of these processes with local stressors”), and C3.4 (“Translate climate forecasts and projections into products that are relevant and useable for improved coral reef ecosystem management and decision-making”). By combining physical oceanographers, modelers and biologists on this project, the PIs have linked complex climate models, oceanographic models, and biological models to create products which are directly relevant to coral reef managers.

In addition, results from this work apply to objective C2.4 (“Promote conservation of coral reef ecosystems through identification of areas that are potentially resilient to climate change and vulnerable areas where actions are likely to increase resilience”). By taking a regional approach to studying the potential consequences of climate change on the oceanic environment, the PIs have compared predicted impacts across the Caribbean Sea and Gulf of Mexico. This can assist managers to prioritize areas for conservation, and to direct resources to where they will be most effectively utilized.

#### **How project supports management of coral reef resources**

Climate change impacts on coral reefs are expected to include increased coral bleaching events, subsequent increases in habitat fragmentation, and changes in larval connectivity mechanisms. However, the likely temporal and spatial extent of these changes is currently poorly known. Coral reef managers have little information on which reef systems are likely to be most severely affected or which existing connections between reefs and/or MPAs are likely to be lost. Outputs from this project can provide advance information to coral reef managers on potential future habitat loss within regional reef systems, and changes in reef resilience. Outputs from the model are available in a standard format, which can be applied to a diverse array of research questions. Several requests for model outputs have already been received, including from FWC, the Gulf of Mexico Fisheries Management Council (GMFMC), and others.

The PIs have created several user-friendly maps and outputs from the model, as examples of its capabilities. These include: (1) A quantitative map output showing how circulation patterns are predicted to change within the study area through to 2100. (2) Predictions of coral reef bleaching locations and rates through to 2100 for the Caribbean region, and predictions of resilience and management needs based on current reef condition.

Other user groups have also used model outputs to generate impact maps for the FL Keys, and other products. Overall, the downscaled model can allow the magnitude and nature of climate change impacts on coral reefs to be better understood. As a result, priority areas for conservation can be more effectively identified, and coral reef managers will be better placed to anticipate future management requirements.

#### **List of project partners and their roles**

- NOAA-AOML, Yanyun Liu/Sang-Ki Lee: Model downscaling

## **Communications, media exposure, capacity building, education and outreach activities**

March 2012: CRCP seminar at Silver Spring, MD.

### **Submissions to CoRIS**

Due to the very large size of the model outputs, model metadata will be provided to CoRIS, with contact details available for data requests.

### **FY2012 Publications**

Liu, Y., Lee, S.K., Muhling, B.A., Lamkin, J.T., Enfield, D.B. (2012) "Significant Reduction of the Loop Current in the 21st Century and Its Impact on the Gulf of Mexico," *Journal of Geophysical Research – Oceans* 117: C05039.

### **FY2012 Presentations**

Muhling, B.A., Liu, Y., Lee, S.K., Lamkin, J.T., Roffer, M.A., Muller-Karger, F., "Developing downscaled climate models for coral reef management into the 21st Century", CRCP seminar, Silver Spring, MD, USA, March, 2012.

Muhling, B.A., Liu, Y., Lee, S.K., Lamkin, J.T., "Projected climate change impacts on spawning grounds of Atlantic tunas in the northern Gulf of Mexico", CLIOTOP WG1 workshop, Shimizu, Japan, 2012

### **Setbacks or challenges encountered in FY2012**

The team's main challenges in 2012 were accessing computer resources to complete model runs, and re-running the model to reflect the new RCP scenarios. However, despite these challenges, all activities were completed as proposed.

### **Comments on future direction of project**

The final year of the project will be primarily concerned with updating the downscaled model to run on the new RCP scenarios, and finalizing outputs for coral reef management uses. We do not anticipate any issues with completing these tasks, and we anticipate that CoRIS products will be delivered on schedule.

<b>Project ID#:</b>	20692-2012
<b>Title:</b>	C173 Climate Change Impacts: Potential for Recovery/Resilience of Corals and Algal Interference
<b>PIs and co-PIs:</b>	Margaret Miller (SEFSC)
<b>Duration of Project:</b>	Year 2 of 2
<b>Project Category:</b>	Reduce Impacts of Climate Change

#### **Brief description of activities conducted in FY2012**

Coral spawning was monitored in the upper FL Keys with poor spawning by elkhorn and staghorn (*Acropora*) coral. *Montastraea faveolata* larvae were collected both in Aug and Sept enabling two attempts at proposed experiments. The project team conducted successful experiments on 1) settlement in ambient conditions on substrates conditioned in high (900ppm) versus low (390 ppm) CO<sub>2</sub>; 2) larval respiration rates in temp\*CO<sub>2</sub> treatments, and 3) post-settlement growth. However, quantifying larval survivorship in sustained CO<sub>2</sub> conditions remains challenging. In addition, the project team made four seasonal measurements of baseline productivity (net photosynthesis) of both calcareous and fleshy macroalgae in the field at Cheeca Rocks, where fully characterized environmental CO<sub>2</sub> conditions are provided by Moored Autonomous pCO<sub>2</sub> (MAP-CO<sub>2</sub>) buoy.

#### **Description of accomplishments & results**

Respiration rates of *M.faveolata* larvae varied significantly among the 4 treatments (29 vs 31°C crossed with 400 vs. 900 ppm CO<sub>2</sub>). Respiration was significantly elevated under both increased temperature and increased CO<sub>2</sub> relative to the control conditions (0.57 and 0.49 respectively vs. 0.35 nmol O<sub>2</sub> larvae<sup>-1</sup>min<sup>-1</sup>, p=0.00 and 0.02). This increase was not observed when both of these factors were combined (0.38 vs. 0.35, p=0.85). Elevated metabolic rates at increased temperatures may account for higher respiration rates at 31°C. Studies of adult invertebrates have yielded reduced metabolism at increased CO<sub>2</sub>, but aposymbiotic coral larvae may exhibit a different response as seen in this study. The combined stress of the high temperature/high CO<sub>2</sub> treatment may depress cellular response and explain the measured values. Further studies are needed as respiration rates can affect larval dispersal and ultimately the repopulation of Caribbean reefs.

When large batches of *M.faveolata* larvae in normal ambient conditions are offered settlement substrates that had been conditioned in 400 vs. 900 ppm CO<sub>2</sub> treatments, they settled in high densities on the 400 ppm conditioned, exposed surfaces. *M.faveolata* larvae are known for seeking dark, cryptic settlement surfaces and no preference was seen between treatments on dark, cryptic bottom surfaces of the conditioned tiles (Fig. 1).

Baseline seasonal measurements of macroalgal productivity at Cheeca Rocks shows contrasting patterns between the dominant fleshy algae (*Dictyota*, likely *D. pinnatifida*) and the calcareous *Halimeda tuna*. Photosynthesis was highest for *Dictyota* spp. in August which correlated to the highest seasonal temperatures whereas *H. tuna* exhibited highest rates in June as opposed to August, suggesting that the thermal optimum for this species may be lower than the maximum yearly temperature in the FL Keys. Calcification rates were also measured for *H. tuna* but have not yet been analyzed.

Lastly, in Aug 2012 the team discovered seven surviving colonies (on two substrates) of *A.palmata* resulting from larval settlement activities in Aug 2011 (fig 2). After consultation with FKNMS managers, these colonies were returned to Sand Island reef so the team could continue to monitor their growth.

### **How project supports goals & objectives of CRCP**

Much of the degradation of Caribbean reefs in the past decade(s) relates to decreased coral abundance and consequent coral/algal 'phase shifts'. Reef plants have both positive (settlement cues) and negative (preempting substrate, trapping sediment, allelopathy) interactions with corals and their larvae. Emerging experimental work now shows that OA and warming temperatures can each negatively impact multiple early stages of Caribbean reef building corals. However, these impacts are occurring together and combined impacts (OA and warming) must be understood. Meanwhile, virtually nothing is known about the impacts of OA (alone or in tandem with warming) on either calcareous or non-calcareous reef plants or their complex interactions with corals.

### **How project supports management of coral reef resources**

These studies directly address management's research needs, articulated in the jurisdictional management priorities for both PR (4A2) and USVI (5.1). FL management priority Climate Change B2.1 calls for a comprehensive climate change predictive model, and calls for additional data collection to support it. These stated management objectives recognize that better understanding of cumulative climate impacts, both direct on vulnerable coral life phases and indirect on coral/algal interactions, is needed for managers to have realistic expectations of future impacts and develop more effective resilience strategies. These studies also directly address the priorities in the NOAA OA Implementation Strategy and the draft CRCP OA Strategy and the need for better understanding of climate change impacts on ESA listed corals as two of the target species are currently listed and the third is under active consideration for listing. The project provides documentation of coral spawning and larval success for three key species in the Keys, addressing FL Man Priority FDOU Obj D1.2.

### **List of project partners and their roles**

- UM-RSMAS, PI Langdon and graduate student Fisch: collaborators
- FKNMS, MacLaughlin: collecting and culturing coral spawn in the FL Keys
- Florida Aquarium (Sexual Coral Reproduction Foundation (SCORE) partners): collecting and culturing coral spawn in the FL Keys
- Coral Restoration Foundation: collecting and culturing coral spawn in the FL Keys
- State University of New York-Buffalo, Coffroth: collecting and culturing coral spawn in the FL Keys
- FWC: collaborating partner - documented mass spawning by *Dendrogyra cylindrus* (proposed ESA endangered, State of Florida listed species) in the FL Keys

### **Communications, media exposure, capacity building, education and outreach activities**

- CRCP/One NOAA science seminar, Silver Spring, 7 June 2012
- Collaborated with and presented to coral Teen Research Underwater Explorers (TRUE Dive team; [truediveteam.org](http://truediveteam.org)), a group of high school scientific divers based in Tampa, FL.

### **Submissions to CoRIS**

None

### **FY2012 Publications**

None

### **FY2012 Presentations**

None

### Setbacks or challenges encountered in FY2012

The PIs were challenged by a lack of expected spawning by *Acropora spp.* in the FL Keys and therefore were unable to perform experiments with these species. Meanwhile, the contained flow-through chambers (50 ml tubes fitted with mesh tops/bottoms and re-circulated CO<sub>2</sub> treatment water from a reservoir via peristaltic pumps) designed by the PIs, and built for larval exposure to the CO<sub>2</sub> treatments in Key Largo, were not successful in maintaining stable chemical conditions. Therefore, all larval exposure experiments will be performed in Miami next year.

### Comments on future direction of project

This two-year project was stretched over a three-year contract period so additional algal production and larval experiments will be conducted in FY13. The team will again attempt to perform larval survivorship and settlement within the four treatment conditions in newly designed sub-containers to be floated directly in the CO<sub>2</sub>/Temp treatment tanks at the UM-RSMAS Hatchery. Additional larval respiration experiments are also planned.

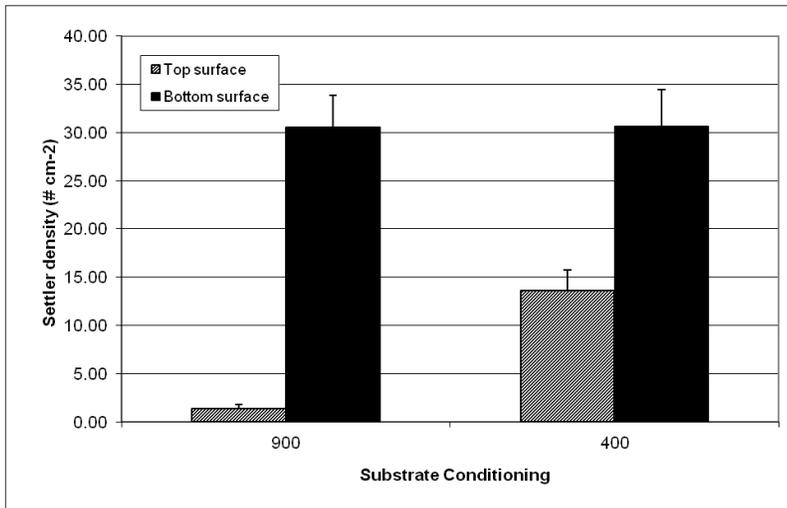


Figure 1. Settlement of *M. faveolata* larvae in normal seawater onto tiles conditioned in 400 (n=17) versus 900 ppm (n=19) CO<sub>2</sub> at UM Hatchery. Larvae were left to settle with tiles for two days after which the tiles were removed from the batch of larvae and quantified 4-5 days later. Data displays the number of polyps that were fully settled onto the substrate per square centimeter for both the top and bottom of the flat ceramic tiles. *M. faveolata* are known to seek dark undersides to settle, but appear to express a preference for control-CO<sub>2</sub> conditioned substrate when dark undersides are not available.

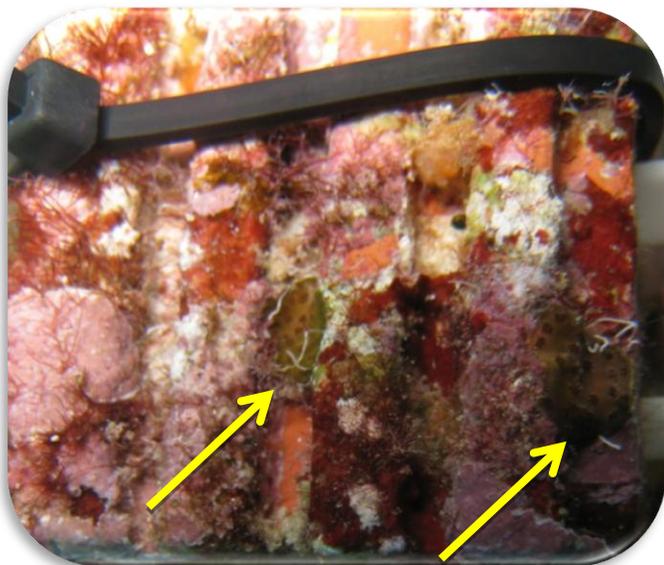


Figure 2: Settlement substrate from 2011 which contains two surviving juveniles of *A. palmata* settled from larvae in 2011. These survivors were detected in Aug 2012 and replaced at Sand Island reef to hopefully continue growing.

## V. SOCIOECONOMICS

<b>Project ID#:</b>	455-2012
<b>Title:</b>	Socioeconomic Assessment of the St. Croix Gill and Trammel Net Ban
<b>PIs and co-PIs:</b>	Juan Agar (SEFSC) and Flavia Tonioli (CIMAS/UM)
<b>Duration of Project:</b>	Year 1 of 1
<b>Project Category:</b>	Socioeconomics

### **Brief description of activities conducted in FY2012**

In July of 2012, 43 in-person interviews were conducted with former gill and trammel net fishermen and other stakeholders that participated in the buy-back and ban process. The surveys elicited information about their demographics, participation in the fishery, changes in fishing practices and their views about the biological, economic and social impacts of the ban. Likert scale responses were used to investigate whether the ban protected parrotfish populations, mitigated bycatch, and protected coral reefs. They were also used to probe whether the ban had impacted fishermen's ability to support themselves and their families, generated economic hardships to the local fishing community, and reduced user conflicts.

### **Description of accomplishments & results**

This project investigated the main socio-economic impacts caused by the gill and trammel net ban and buy-back in St. Croix, USVI. The objective of the ban was to protect parrotfish populations and minimize by-catch and gear-habitat interactions whereas the intent of the buy-back was to minimize the socio-economic hardship of the soon to be enforced net ban.

A preliminary assessment of the survey results revealed conflicting perceptions about the usefulness of the buy-back since stakeholders' views were strongly influenced by the process and outcome. Predictably, net fishermen were the most dissatisfied user group because it took away their most profitable fishery without adequate compensation. While this sentiment was shared by several resource managers; as a group, they believed that they did their best with the available landings information and buy-back funds. Many members of the environmental, diver, charter and resource manager groups believed that the process had been fair since it was the result of a lengthy, consultative process. A few members of the environmental, diver, charter community also believed that the process had been fair because fishermen had received some compensation to transition to other gears. Witnesses to the buy-back process indicated that fishermen were more concerned with the ban than with the buy-back itself because of the adverse impact of their livelihoods. Fishermen believed that resource managers had their mind set on the ban and did not adequately consider the use of seasonal closures or other fisheries management tools.

The survey also overwhelmingly showed net fishermen believed that the net ban had adversely impacted the profitability of their fishing operations. They offered three main reasons for their dissatisfaction. First, nets were substantially more productive than other fishing gears; hence, when the ban became effective, parrotfish landings and the associated earnings decreased significantly. Fishermen reported that their revenues and landings decreased by 45% and 56% respectively. Second, the net prohibition forced them to make substantive investments in alternative fishing gears, especially traps. Fishermen pointed out that the buy-back funds received were insufficient to transition to other

gears. Moreover, many reported that they could not afford to take on additional loans to purchase materials (e.g., wire, ropes, buoys) and fishing equipment (e.g., spear guns, scuba) to stay in business since they already held loans for the house, truck and boat. Third, the new gears were not only less productive but also more expensive to operate and maintain. A number of fishermen stated that setting up and running their operation had become more costly because they had to venture further out. They stated that the duration of their fishing trips (measured in hours) had increased by 22%. Finally, fishermen reported that the lower landings and profits had made it harder for them and their crews to make a living. Only five of the original nine net fishermen that were bought out remained as owner-operators.<sup>1</sup> Also, fishermen reported that the number of crew employed decreased by 50%.

### **How project supports goals & objectives of CRCP**

This study addressed CRCP's fishing impacts goal No. 1, specifically objectives F.1.6 ("conduct applied biological, social and economic research and monitoring to evaluate the effectiveness of coral reef ecosystem management actions on key species or groups"), and F1.1 ("support the creation of improvement of coral reef fisheries management plans that address ecological, social and economic considerations"). Additionally, this study addressed fishing impacts goal No. 3, specifically, objective F3.4 ("conduct biological research and socio-economic research and monitoring necessary to assess the effectiveness of compliance and enforcement activities, understand community concerns, flag roadblocks to implementation and incorporate into management efforts").

In terms of jurisdiction goals, the study covered USVI Goal 4, specifically USVI Objective 4.1 ("Reduce fishing effort on prioritized key coral reef associated species or functional groups"), as it investigated parrotfish landings after the net ban. As well, it addressed USVI Goal 3, "Increase the ability to effectively enforce existing rules, regulations and laws (specifically USVI Objective 3.4)," since the project investigated the fishermen's and stakeholders perceptions of the buy-back and ban efficacy.

The buy-back program was a previous CRCP-funded project, however no socioeconomic or fishery impact assessment was prepared after the implementation of the buy-back. The database on fishermen's perceptions about the effectiveness of the net ban and the buy-back program can assist to determine the success of management measures and provide insight into the efficacy of enforcement efforts. Research findings about the fishermen's adaptations in terms of effort production, gear switching and targeting can help managers analyze the performance of the proposed management actions on fishermen.

### **How project supports management of coral reef resources**

Developing policies that promote the sustainable use of marine ecosystems and ensure the economic viability of fishing communities is central to improving governance of small-scale fisheries around the world. This project sought to identify the strengths and weaknesses of gear buy-backs and bans as tools to balance competing biological and economic goals. The PIs assessed the performance of these management tools by triangulating information from in-person interviews with government statistics and reports. This type of research is important because the lessons learned can help strengthen fisheries management in small-scale settings.

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<sup>1</sup> Two of them reported that they had begun fishing on full-time basis for others. A third one became a part-time fisherman who also worked in construction to make a living. Oddly, two of these former owner operators began fishing for a former net fisherman who participated in the buy-back. The fourth fisherman no longer lives on the island.

### **List of project partners and their roles**

Caribbean Fishery Management Council (CFMC): liaisons with the local community

USVI Division of Fish and Wildlife (DFW): liaisons with the local community

### **Communications, media exposure, capacity building, education and outreach activities**

None

### **Submissions to CoRIS**

Report in Progress

### **FY2012 Publications**

A peer review paper describing the net buy-back and ban experience is in preparation.

### **FY2012 Presentations**

None

### **Setbacks or challenges encountered in FY2012**

This study met the original objectives of the proposal. However, the sampling protocol had to be modified. The original plan was to sample all 44 documented gill and trammel net fishermen (35 gillnet and 9 trammel net fishermen) which were identified in the 2003 USVI Census of Commercial Fishermen (Kojis, 2004), a CRCP funded product. However, while conducting the fieldwork, the USVI Department of Fish and Wildlife and CFMC liaisons suggested that the size of the target population was high because many fishermen had misreported the gears they actually used or owned to preempt future regulations. The liaisons suggested that about half of the team's identified target population were bona fide net fishermen. Therefore, the co-PI ended up interviewing 8 of the 9 net fishermen that participated in the buy-back (9<sup>th</sup> fisherman left the island), and 9 other bona fide former net fishermen. Key members of the resource management, environmental, diving and charter community were surveyed opportunistically based on the recommendations of the liaisons.

### **Comments on future direction of project**

None



A fisherman holding a Crucian Gillnet (Kojis, 2004)

## VI. PROTECTED CORALS

<b>Project ID#:</b>	20727-2012
<b>Title:</b>	O171 Evaluation of ESA listed <i>Acropora</i> spp. Status and Actions for Management and Recovery
<b>PIs and co-PIs:</b>	Margaret Miller (SEFSC) and Dana Williams (CIMAS/UM)
<b>Duration of Project:</b>	Year 2 of 3, ongoing project
<b>Project Category:</b>	Other, Protected Corals

### Brief description of activities conducted in FY2012

Surveys conducted in 2012 marked the 9th year of this study for FL sites (7th for Curacao sites) making this effort the longest known demographic study of FL Keys *A. palmata* to date. Also, two studies evaluating proactive management actions (predator removal and health/disease dynamics in outplanted colonies) continued. A two-year field study comparing disease dynamics in restored vs. wild colonies of *A. cervicornis* was completed along with testing disease mitigation treatments. Meanwhile a study evaluating costs and benefits of corallivorous snail removal from *A. palmata* will be completed in FY13.

### Description of accomplishments & results

In 2012, the PIs completed 3 *Acropora palmata* survivorship and recruitment surveys at each of 28 150 m<sup>2</sup> study plots at 8 reef sites in the FL Keys and established one additional study plot. The PIs also continued a partnership with FWC as they continue an *A. palmata* monitoring project in the middle and lower Keys and Biscayne National Park utilizing the methods established as part of this project in FY06 (see Williams et al. 2006 NOAA Tech Memo NMFS –SEFSC 543), though funding for this partner effort will cease in FY13. In May 2012, monitoring sites (4 sites, 12 study plots) in Curaçao were re-surveyed as planned. Data from the first six years was used to compile a report and also resulted in the submission of a manuscript to a peer reviewed journal. These long term monitoring analyses have resulted in three peer-reviewed publications (see publications below).

Since 2004, when this monitoring began, there has been a loss of 45% of the *A. palmata* from these study plots. Most of this decline occurred as a result of the 2005 hurricane season, with modest (10%) subsequent recovery. Analysis of threats facing *A. palmata* has revealed that in the absence of hurricane impacts, disease is the primary cause of tissue loss to standing colonies and accounts for more than one third (36%) of lost tissue followed by snail predation (26%) and skeletal breakage (20%). Based on this finding two *in situ* experiments were begun in 2011; one evaluating removal of coral-eating snails (to be completed in July 2013) and a second evaluating *in situ* techniques (applying epoxy band to disease line and excising healthy branch tips from diseased colonies to reduce disease mortality (completed in Nov 2012) (See Figures 1 & 2 below). Between May-Nov 2012, the team undertook a second year of regular surveillance of restocked *A. cervicornis* colonies at 6 sites and applied these disease mitigation treatments to diseased colonies they encountered, paired with appropriate controls. Results were ambiguous with some treatment replicates showing arrested tissue loss and some showing complete mortality. Results of this study were presented at the International Coral Reef Symposium and are being submitted to a peer-reviewed journal.

The predator removal experiment was established in existing study plots using a BACI design. At each site (n=6) the team removed the snails from *A. palmata* only in one plot, all host coral in a second plot

and a third plot served as a control. Four quarterly removals were conducted in the first year of the study with the rate of snail recolonization being quantified in the second year of the study (estimated to be ~ 4-5 years to reach baseline snail density). The cost of snail removal was about 1.2 min of dive time per colony, and results indicate that no significant benefit is gained by removing snails from non-*Acropora* host corals in the area.

### **How project supports goals & objectives of CRCP**

This project contributes to several of the priority CRCP objectives and focuses on the persistence and recovery of reef coral (e.g., what factors are leading to coral decline and how can this trend be reversed?). For instance, this project contributes to CRCP objective F2.5, “Conduct biological and socioeconomic research and monitoring to assess the performance of MPAs with respect to protection and restoration of key coral reef ecosystem components and functions.” Five (5) of the seven (7) demographic monitoring sites are in no-take reserves. *Acropora palmata* provides habitat for economically important fisheries species and structural protection for coastal habitats as a ‘key taxa’ in reef crest environments and this demographic monitoring provides means to assess stability or increase in *A. palmata* abundance in these areas. The project also supports objective F2.3, “identify MPAs that require increased protections or improved management, and areas to be considered for siting of new MPAs that protect key coral reef ecosystem components and functions.” Proposed experiments will conserve *Acropora* live tissue and may indicate an effective management tool to conserve additional tissues to contribute towards MPA goals of a healthy and robust coral reef structure. Lastly, this project supports objective C4.1, “Facilitate the identification, development, and testing of intervention measures to reduce stress from climate change and OA on coral reef ecosystems in field settings.” Any preservation of live coral, particularly threatened ones, increases population resilience. The current project evaluates two direct intervention strategies for mitigating coral loss to predation and disease to provide cost/benefit to managers.

### **How project supports management of coral reef resources**

This project directly addresses mitigation and recovery strategies developed in the draft *Acropora* recovery plan which is still in review. Additionally, FL managers articulated several priorities that were addressed by this project. Specifically Florida identified *Acropora* monitoring as one of its top 5 mapping and monitoring needs to support management, as stated in the CRCP Coral Reef Ecosystem Integrated Observing System (CREIOS) Workshop Report (Morgan & Waddell (eds) 2009, p.2). Similarly, endangered species recovery and reef restoration both appear as FL management priorities (p.19 Morgan & Waddell 2009) and both the intervention strategy evaluation experiments proposed directly address this priority. More generally, Florida managers identified a need to better assess coral recruitment (including *Acropora* spp.) within their region (p.22, Morgan & Waddell 2009). These FL priorities articulated in the CREIOS report are backed up in the Florida Reef Management Priorities document which calls for implementation of the CREIOS Workshop outcomes.

### **List of project partners and their roles**

- NMFS/SERO Protected Resources Division: provided co-funding for monitoring of listed spp.
- Coral Restoration Foundation: collaborated on disease surveillance/mitigation experiments by providing access to nursery and outplanted populations.
- Florida/FWRI: coordinated and cross-trained for the ESA Section 6 project funded to expand demographic monitoring throughout U.S. territories

### **Communications, media exposure, capacity building, education and outreach activities**

Researchers provided on-site training on field demographic monitoring methods and protocols for territorial partners at the University of the Virgin Islands (UVI) in December 2011. Williams and Miller participated in informal 'Florida Acropora assessors' meeting in Aug 2012 at NSU. Dr. Williams also served on the Masters' Committee of UVI student, Alexis Sabine.

### **Submissions to CoRIS**

See below Publications

### **FY2012 Publications**

Williams DE, Miller MW (2012) Attributing mortality among drivers of population decline in *Acropora palmata* in the Florida Keys (USA). Coral Reefs. DOI 10.1007/s00338-011-0847-y

Vardi T, Williams DE, Sandin SA (2012) Population dynamics of threatened Elkhorn coral in the northern Florida Keys, USA. Endangered Species Research 19: 157–169.

Kiel C, Huntington BE, Miller MW (2012) Tractable field metrics for restoration and recovery monitoring of staghorn coral, *Acropora cervicornis*. Endangered Species Research 19: 171–176 doi: 10.3354/esr00474

### **FY2012 Presentations**

Williams DE 'The future of Elkhorn coral in the Florida Keys'. Annual public lecture series, Dagny Johnson Key Largo Hammock Botanical State Park. January 11, 2012

Miller et al. "Disease dynamics and mitigation in restocked *Acropora cervicornis* populations." Oral Presentation at ICRS, Cairns Australia July 2012

Miller, MW. CRCP/OneNOAA Seminar, June 2012

### **Setbacks or challenges encountered in FY2011**

It appears that the ESA Section 6 project funding to state and territorial partners, after substantial cuts to their 2<sup>nd</sup> and 3<sup>rd</sup> year budgets (of initial 3 year award), is not being renewed. This means that despite substantial investment in developing capacity in these partners to collaborate on *A.palmata* demographic monitoring, monitoring coverage for these listed species within the U.S. range will decline.

### **Comments on future direction of project**

The PIs intend to continue this long-term monitoring which continues to provide insights on status/recovery of listed corals in the upper FL Keys and comparison populations in Curaçao. The long term data set is enabling them to undertake robust Before-After Control-Impact (BACI) design evaluations for potential management/recovery action of snail predator removal. They anticipate additional project components to advance the scientific basis for recovery actions in future.

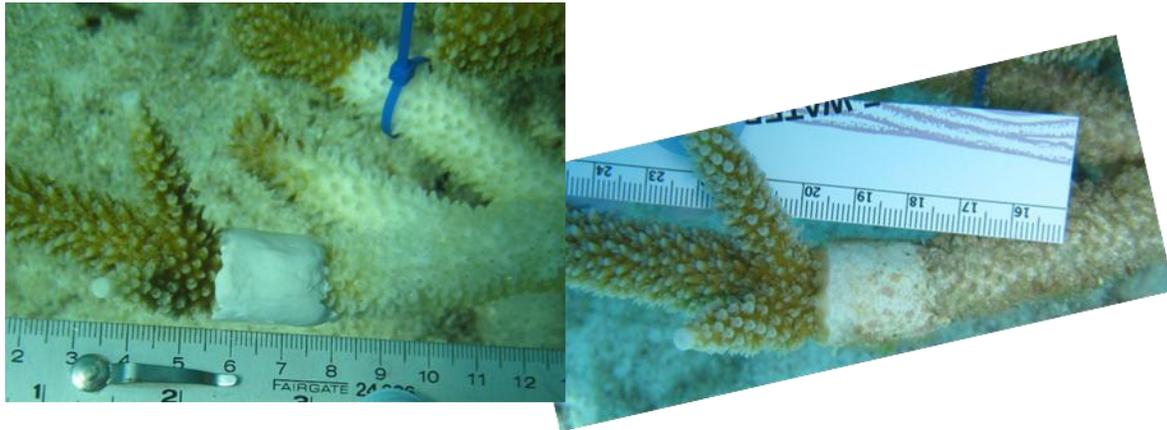


Figure 1. Examples of an epoxy treatment intended to halt progression of disease in *Acropora cervicornis*. The image at right shows the application of the epoxy band (EB) treatment, the left image shows successful arrest of tissue loss and beginning growth over the EB at one month post treatment.

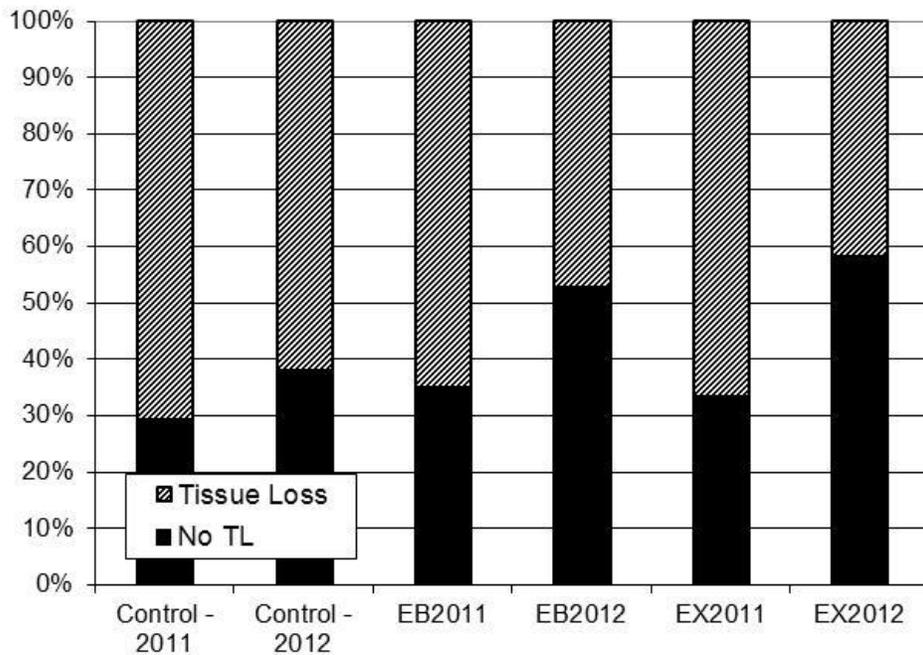


Figure 2. Results of experimental disease mitigation trials showing response in each year for Epoxy Band (EB), Excision (EX) and Control (cable tie placed around disease margin on a branch) treatments as the percent of replicates showing arrested tissue loss after one month. Chi-Squared Goodness of Fit tests indicate no significant difference in the proportions of the three treatments showing continued tissue loss when all replicates across years are pooled.

## VII. COUNCIL COOPERATIVE AGREEMENT ACTIVITIES

<b>Project ID#:</b>	SAFMC Cooperative Agreement: NA11NMF4410061, GMFMC Cooperative Agreement: NA11NMF4410063
<b>Title:</b>	South Atlantic Bight MPAs and Deepwater Coral HAPCs: Characterization of Benthic Habitat and Fauna Synthesis of Information on Octocoral Biology, Ecology, and Fisheries in the South Atlantic in Support of Effective Management Survey of Habitat and Fish Assemblages in Three Marine Reserves on the West Florida Shelf
<b>PIs and co-PIs:</b>	South Atlantic Bight MPAs: Stacey Harter (SEFSC), Andrew David (SEFSC), John Reed (Florida Atlantic University) Octocorals: Andrew David (SEFSC) Gulf MPAs: Andrew David (SEFSC) and Matthew Campbell (SEFSC)
<b>Duration of Project:</b>	Year 2 of 3
<b>Project Category:</b>	Council Cooperative Agreement Activities

### Brief description of activities conducted in FY2012

The SAFMC and GMFMC requested that SEFSC conduct targeted research and analysis activities included under their respective Cooperative Agreements with CRCP. On behalf of SAFMC, SEFSC is executing the following two projects: South Atlantic MPAs and Deepwater Coral HAPCs: Characterization of Benthic Habitat and Fauna; and Synthesis of Information on Octocoral Biology, Ecology, and Fisheries in the South Atlantic in Support of Effective Management. On behalf of GMFMC, SEFSC is executing the project: Survey of Habitat and Fish Assemblages in Three Marine Reserves on the West Florida shelf. All three of these projects have a three year time horizon. While funding was initiated in FY11, work will be conducted predominantly from FY12 through FY14.

### Description of accomplishments & results

*South Atlantic Bight MPAs and Deepwater Coral HAPCs: Characterization of Benthic Habitat and Fauna:*  
The NOAA Ship PISCES was secured for the field work component and a cruise was executed in July 2013. The cruise departed and returned to Mayport Naval Air Station in Jacksonville, FL. A contract for a remotely operated vehicle (ROV) was awarded to the University of North Carolina at Wilmington (UNCW) to support this cruise. This vehicle has been used in several expeditions to the MPAs, dating back to 2004 and was again successful in meeting the goals of the project. Co-PI John Reed of Florida Atlantic University Harbor Branch Oceanographic Institute is continuing the analysis of historical ROV and submersible dives in the areas now included within the deepwater Coral Habitat Areas of Particular Concern (CHAPCs).

*Synthesis of Information on Octocoral Biology, Ecology, and Fisheries in the South Atlantic in Support of Effective Management:*

The project awarded a contract to Dr. Chuck Messing at NSU to conduct a shallow water octocoral identification workshop and develop an on-line identification tool – both of these activities took place in early FY12. A subcontract awarded to NSU was executed in Summer 2012 (via CIMAS) and a research associate, Ms. Espitia, joined the research group. Ms. Espitia focused on gorgonians for her graduate work and was an active participant in the octocoral identification workshop. Since award of the subcontract, the primary accomplishment has been the acquisition and organization of existing primary

and secondary literature pertaining to octocorals of the U.S. South Atlantic. Ultimately this extensive reference database will be one of the project deliverables. The project team has begun to organize and analyze existing data sets from southeastern FL on the distribution, density, and size structure of gorgonians in hard-bottom and coral reef habitats. The team has initiated contact with historical and current marine life collectors in the region and anticipates conducting extensive interviews and trips in 2013.

*Survey of Habitat and Fish Assemblages in Three Marine Reserves on the West Florida Shelf:*

The NOAA R/V *Caretta*, a 58 ft shrimp boat owned by NOAA and operated by the SEFSC Pascagoula Laboratory, was the platform used to complete the field component of this project. This year, the project again surveyed a new MPA, The Edges, which lies between two long-standing MPAs: Madison-Swanson and Steamboat Lumps. Open-to-fishing control areas were also surveyed. Analysis of video data for fish identification and enumeration, as well as habitat determination, is underway and should be completed before the end of calendar year 2013. Fish length analysis and database entry and statistical analysis of all data will be completed by January 2014.

**How project supports goals & objectives of CRCP**

*South Atlantic Bight MPAs and Deepwater Coral HAPCs: Characterization of Benthic Habitat and Fauna:*

This project is in direct support of SAFMC activities to characterize protected deep water coral ecosystems and test their efficacy for the protection of five deepwater grouper and two tilefish populations. It directly addresses the following CRCP National Goals and Objectives: F2.1, "Identify, characterize and rank priority areas for protection within each jurisdiction, including (but not limited to): spawning sites, nursery habitats, or other areas critical to particular life-history stages; biodiversity hotspots; areas with greatest resilience or potential for restoring resilience; and areas facing the greatest threats," and F2.5, "Conduct biological and socioeconomic research and monitoring to assess the performance of MPAs with respect to protection and restoration of key coral reef ecosystem components and functions."

*Synthesis of Information on Octocoral Biology, Ecology, and Fisheries in the South Atlantic in Support of Effective Management:*

This project directly links to the CRCP National Goals and Objectives including: obtain essential life history information on coral reef species; obtaining necessary information on fishing effort in U.S. coral reef ecosystems by measuring fishing intensity, fishing mortality, frequency, area of coverage, community dependence, etc. to inform management activities; and assessing the adequacy of current coral reef fishing regulations including revisions of regulations as needed and increasing compliance with regulations that further coral reef ecosystem conservation. This project provides essential information for the conservation and management of South Atlantic coral resources under the SAFMC's Coral, Coral Reef and Live/Hardbottom Habitat FMP. The proposed work conforms to the "Coral Reef National Action Strategy" and the "National Action Plan to Conserve Coral Reefs". This project was developed at the request of the SAFMC to help them, and the state of Florida, effectively manage the octocoral fishery which currently has very little data available for science-based management.

*Survey of Habitat and Fish Assemblages in Three Marine Reserves on the West Florida Shelf:*

This project is also in direct support of GMFMC activities to characterize protected deep water coral ecosystems and test the efficacy of MPAs as management tools. It directly addresses the following CRCP National Goals and Objectives: F2.1, "Identify, characterize and rank priority areas for protection within each jurisdiction, including (but not limited to): spawning sites, nursery habitats, or other areas critical to particular life-history stages; biodiversity hotspots; areas with greatest resilience or potential for

restoring resilience; and areas facing the greatest threats,” and F2.5, “Conduct biological and socioeconomic research and monitoring to assess the performance of MPAs with respect to protection and restoration of key coral reef ecosystem components and functions.”

#### **How project supports management of coral reef resources**

*South Atlantic Bight MPAs and Deepwater Coral HAPCs: Characterization of Benthic Habitat and Fauna:*  
The results of this MPA and CHAPC monitoring program will be used by the SAFMC during their evaluation of the protected areas. Continuation of the monitoring program will insure the SAFMC remains well informed of changes within reef fish populations and coral habitats associated with these areas.

#### *Synthesis of Information on Octocoral Biology, Ecology, and Fisheries in the South Atlantic in Support of Effective Management:*

This project will assist the SAFMC and the State of Florida in arriving at scientifically-derived levels of Acceptable Biological Catch for octocorals under its FMP. The SAFMC has been working to establish fishing level parameters mandated in the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006. However, data on the status of the octocoral population in FL, where the fishery operates, are very limited. While harvest information gathered by FWC is available, not enough information exists on the species being harvested, harvest areas, or practices. The SEFSC does not maintain a landings database for octocorals but relies instead on the FWC to supply the information since the vast majority of landings originate in State waters. Obtaining information on population status, species harvested, use of this habitat by managed species, etc., would directly address management objectives in the SAFMC’s Coral FMP.

#### *Survey of Habitat and Fish Assemblages in Three Marine Reserves on the West Florida Shelf:*

This Gulf of Mexico MPA monitoring program continues to be used by the GMFMC during their evaluation of the protected areas. Continuation of the monitoring program will insure the GMFMC remains well informed of changes within reef fish populations and coral habitats associated with these areas.

#### **List of project partners and their roles**

*South Atlantic Bight MPAs and Deepwater Coral HAPCs: Characterization of Benthic Habitat and Fauna:*

- UNCW: owns and operates the ROV which will be used on the upcoming cruise.
- NOS- Charleston: provided geographer to supervise multibeam mapping procedures while at sea.
- College of Charleston: provided student to assist with multibeam mapping and data processing

#### *Synthesis of Information on Octocoral Biology, Ecology, and Fisheries in the South Atlantic in Support of Effective Management:*

- NSU: project personnel, octocoral identification workshop and on-line database
- Dr. Henry Feddern, President of the Florida Marine Life Association: will provide industry support for the project
- Dr. Luiz Barbieri, FWC – will provide state support for the project and access to fishery data

#### *Survey of Habitat and Fish Assemblages in Three Marine Reserves on the West Florida Shelf:*

None

#### **Communications, media exposure, capacity building, education and outreach activities**

None

**Submissions to CoRIS**

None

**FY2012 Publications**

Biannual progress reports were provided to the South Atlantic and Gulf Councils

**FY2012 Presentations:**

Presentation provided to SAFMC on South Atlantic Bight MPA project, along with biannual progress reports.

Presentation provided to GMFMC on Gulf MPA project, along with biannual progress reports.

**Setbacks or challenges encountered in FY2012:**

None

**Comments on future direction of project**

These activities are funded for a three year period, pending positive annual progress reports.

## VIII. LIST OF ACRONYMS

CFMC	Caribbean Fishery Management Council
CHAPC	Coral Habitat Area of Particular Concern
CIMAS	Cooperative Institute for Marine and Atmospheric Studies
CMIP	Coupled Model Intercomparison Project
CoRIS	Coral Reef Information System
CRCP	Coral Reef Conservation Program
CREIOS	Coral Reef Ecosystem Integrated Observing System
CRTFM	U.S. Coral Reef Task Force Meeting
FIU	Florida International University
FL	Florida
FKNMS	Florida Keys National Marine Sanctuary
FMP	Fishery Management Plan
FWRI	Florida Fish and Wildlife Research Institute
ESA	Endangered Species Act
FWC	Florida Fish and Wildlife Conservation Commission
FY	Fiscal Year
GMFMC	Gulf of Mexico Fishery Management Council
MOM4	Modular Ocean Model Version 4
MPA	Marine Protected Area
NCRM	National Coral Reef Monitoring Plan
NESDIS	National Environmental Satellite, Data, and Information Service
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NPS	National Park Service
NSU	Nova Southeastern University
OA	Ocean Acidification
OAR	Oceanic and Atmospheric Research
PI	Principal Investigator
QA/QC	Quality Assurance/Quality Control
RCP	Representative Concentration Pathway
ROV	Remotely Operated Vehicle
RVC	Reef Visual Census
SAFMC	South Atlantic Fishery Management Council
SEFCRI	Southeast Florida Coral Reef Initiative
SEFSC	Southeast Fishery Science Center
UM-RSMAS	University of Miami, Rosenstiel School of Marine and Atmospheric Science
UNCW	University of North Carolina Wilmington
U.S.	United States
USVI	U.S. Virgin Islands
UVI	University of Virgin Islands